WHAT IS CLAIMED IS:

1. A disc storage system having a servo loop for positioning a head over a disc, the servo loop comprising:

a voice coil motor actuator configured to move the head in response to a received servo control signal;

a sensor, located in the head, which is configured to sense servo information located on the disc and produce a servo signal therefrom, the servo signal is combined with a reference signal to produce a position error signal;

a servo controller configured to receive the position error signal and to responsively produce the servo control signal, the servo controller comprising:

a drive signal generator configured to receive the position error signal and to responsively produce a driving energy signal; and

a vibration damping circuit configured to receive the driving energy signal and to responsively produce the servo control signal; and

a real-time adaptive loop shaping circuit configured to detect vibration energy in the position error signal and to responsively adjust at least one parameter of a transfer function of the vibration damping circuit to reduce vibrations at different frequencies in the driving

energy signal.

2. The apparatus of claim 1 wherein the vibration damping circuit includes a notch filter to damp vibrations at high frequency resonance modes, and wherein the real-time adaptive loop shaping circuit is configured to detect vibrations at high frequency resonance modes in the position error signal and to responsively adjust a depth of the notch filter.



- 3. The apparatus of claim 2 wherein the real-time adaptive loop shaping circuit adjusts the depth of the notch filter by modifying a gain of the notch filter.
- 4. The apparatus of claim 2 wherein the real-time adaptive loop shaping circuit includes a band-pass filter to detect vibrations at high frequency resonance modes in the position error signal.
- 5. The apparatus of claim 1 wherein the vibration damping circuit includes a non-repeatable runout compensator to cancel non-repeatable runout disturbances, and wherein the real-time adaptive loop shaping circuit is configured to detect non-repeatable runout disturbances in the position error signal and to responsively adjust at least one parameter of a transfer function of the non-repeatable runout compensator.
- 6. The apparatus of claim 5 wherein the real-time adaptive loop shaping circuit includes a band-pass filter to detect non-repeatable runout disturbances in the position error signal.
- 7. The apparatus of claim 1 wherein the vibration damping circuit includes a rotational vibration compensator to cancel rotational vibration disturbances, and wherein the real-time adaptive loop shaping circuit is configured to detect rotational vibration disturbances in the position error signal and to responsively adjust at least one parameter of a transfer function of the non-repeatable runout compensator.
- 8. The apparatus of claim 7 wherein the real-time adaptive loop shaping circuit includes a low-pass filter to detect rotational vibration disturbances in the position error signal.

P. The apparatus of claim 1 wherein the vibration damping circuit includes a plurality of disturbance adjustment compensators to cancel vibration disturbances at different frequency ranges, and wherein the real-time adaptive loop shaping circuit is configured to detect vibration disturbances at the different frequency ranges in the position error signal and to responsively adjust at least one parameter of a transfer function of at least one of the plurality of disturbance compensators.

- 10. The apparatus of claim 1 wherein the real-time adaptive loop shaping circuit includes a learning component that adjusts a speed of adaptation of the servo loop.
- 11. A method of maintaining stability in a servo loop used for positioning a head over a disc in a disc drive, the servo loop having a voice coil motor actuator and a servo controller that controls the voice coil motor actuator, the method comprising:
 - (a) generating a servo signal based on the position of the head over the disc;
 - (b) generating an actuator control signal for driving the voice coil motor actuator based on a position error signal, wherein the position error signal is determined by combining the servo signal with a reference signal;
 - (c) detecting vibration energy in the position error signal; and
 - (d) adjusting at least one parameter of a transfer function of the servo controller to attenuate the vibration energy detected in step (c) at different frequencies.
- 12. The method of claim 11 wherein the detecting vibration energy step (c) includes detecting vibrations at high frequency resonance modes, and wherein the adjusting step (c) includes adjusting a depth of a notch filter of the servo controller to reduce vibrations at high frequency resonance modes.

- 13. The method of claim 11 wherein the detecting vibration energy step (c) includes detecting non-repeatable runout disturbances, and wherein the adjusting step (c) includes adjusting at least one parameter of a transfer function of a non-repeatable runout compensator of the servo controller to reduce non-repeatable runout disturbances.
- 14. The method of claim 11 wherein the detecting vibration energy step (c) includes detecting rotational vibration disturbances, and wherein the adjusting step (c) includes adjusting at least one parameter of a transfer function of a rotational vibration compensator of the servo controller to reduce rotational vibration disturbances.
- 15. The method of claim 11 wherein the detecting vibration energy step (c) and the adjusting at least one parameter step (d) is carried out by a real-time adaptive loop shaping circuit.
- 16. A disc drive for storing information on a disc, the disc drive comprising:

 a servo loop for positioning a head over the disc, the servo loop including a

 servo controller and a voice coil motor actuator, the voice coil motor

 actuator is configured to move the head in response to a servo control

 signal generated by the servo controller; and

 a real-time adaptive loop shaping means for attenuating disturbances in the

 servo loop.
- 17. The apparatus of claim 16 wherein: the servo loop further comprises:
 - a sensor, located in the head, which is configured to sense servo information located on the disc and produce a servo signal

therefrom, the servo signal is combined with a reference signal to produce a position error signal; and the real-time adaptive loop shaping means comprises a real-time adaptive loop shaping circuit adapted to:

detect vibration energy in the position error signal and to
responsively adjust at least one parameter of a transfer
function of a vibration damping circuit of the servo
controller to reduce vibrations at different frequencies in the
servo loop.

- 18. The apparatus of claim 17 wherein the vibration damping circuit includes a notch filter to damp vibrations at high frequency resonance modes, and wherein the real-time adaptive loop shaping circuit is configured to detect vibrations at high frequency resonance modes in the position error signal and to responsively adjust a depth of the notch filter.
- 19. The apparatus of claim 18 wherein the real-time adaptive loop shaping circuit adjusts the depth of the notch filter by modifying a gain of the notch filter.
- 20. The apparatus of claim 18 wherein the real-time adaptive loop shaping circuit includes a band-pass filter to detect vibrations at high frequency resonance modes in the position error signal.
- 21. The apparatus of claim 17 wherein the vibration damping circuit includes a non-repeatable runout compensator to cancel non-repeatable runout disturbances, and wherein the real-time adaptive loop shaping circuit is configured to detect non-repeatable runout disturbances in the position error signal and to responsively adjust at least one parameter of a transfer function of the non-repeatable runout compensator.

- 22. The apparatus of claim 21 wherein the real-time adaptive loop shaping circuit includes a band-pass filter to detect non-repeatable runout disturbances in the position error signal.
- 23. The apparatus of claim 17 wherein the vibration damping circuit includes a rotational vibration compensator to cancel rotational vibration disturbances, and wherein the real-time adaptive loop shaping circuit is configured to detect rotational vibration disturbances in the position error signal and to responsively adjust at least one parameter of a transfer function of the non-repeatable runout compensator.
- 24. The apparatus of claim 23 wherein the real-time adaptive loop shaping circuit includes a low-pass filter to detect rotational vibration disturbances in the position error signal.
- 25. The apparatus of claim 17 wherein the vibration damping circuit includes a plurality of disturbance adjustment compensators to cancel vibration disturbances at different frequency ranges, and wherein the real-time adaptive loop shaping circuit is configured to detect vibration disturbances at the different frequency ranges in the position error signal and to responsively adjust at least one parameter of a transfer function of at least one of the plurality of disturbance compensators.
- 26. The apparatus of claim 17 wherein the real-time adaptive loop shaping circuit includes a learning component that adjusts a speed of adaptation of the servo loop.